McHenry County Water Resource Action Plan: Industrial BMPs

Geosyntec Consultants – Brian Valleskey and Lee Hauser

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- National Firm with 2 IL Offices (Oak Brook, Chicago)
- Engineers & Scientists with Water & Environmental Resources Emphasis
- Local Focus and Expertise in Water Quality: Fox River Study Group (FRSG) Water Quality Model
- Industrial stormwater expertise – Nationwide

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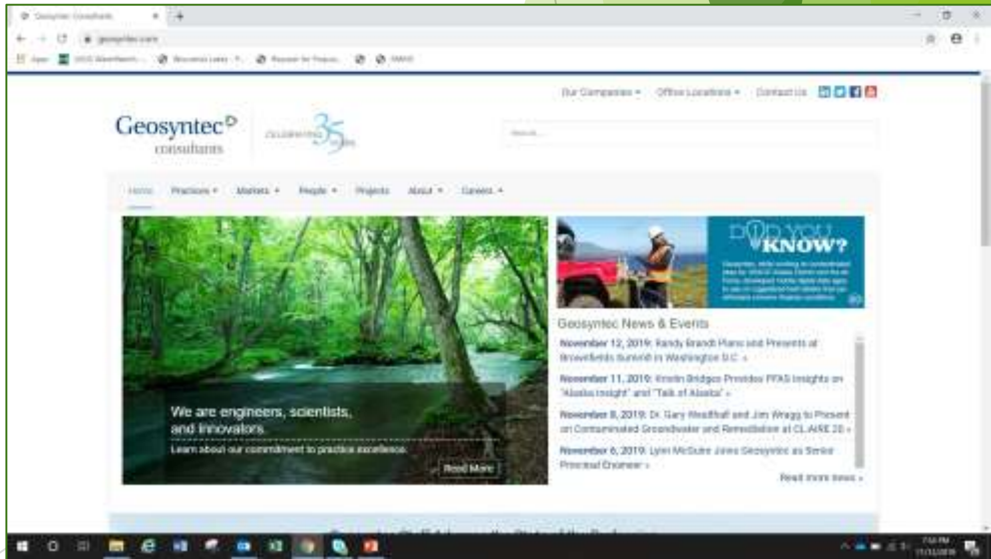
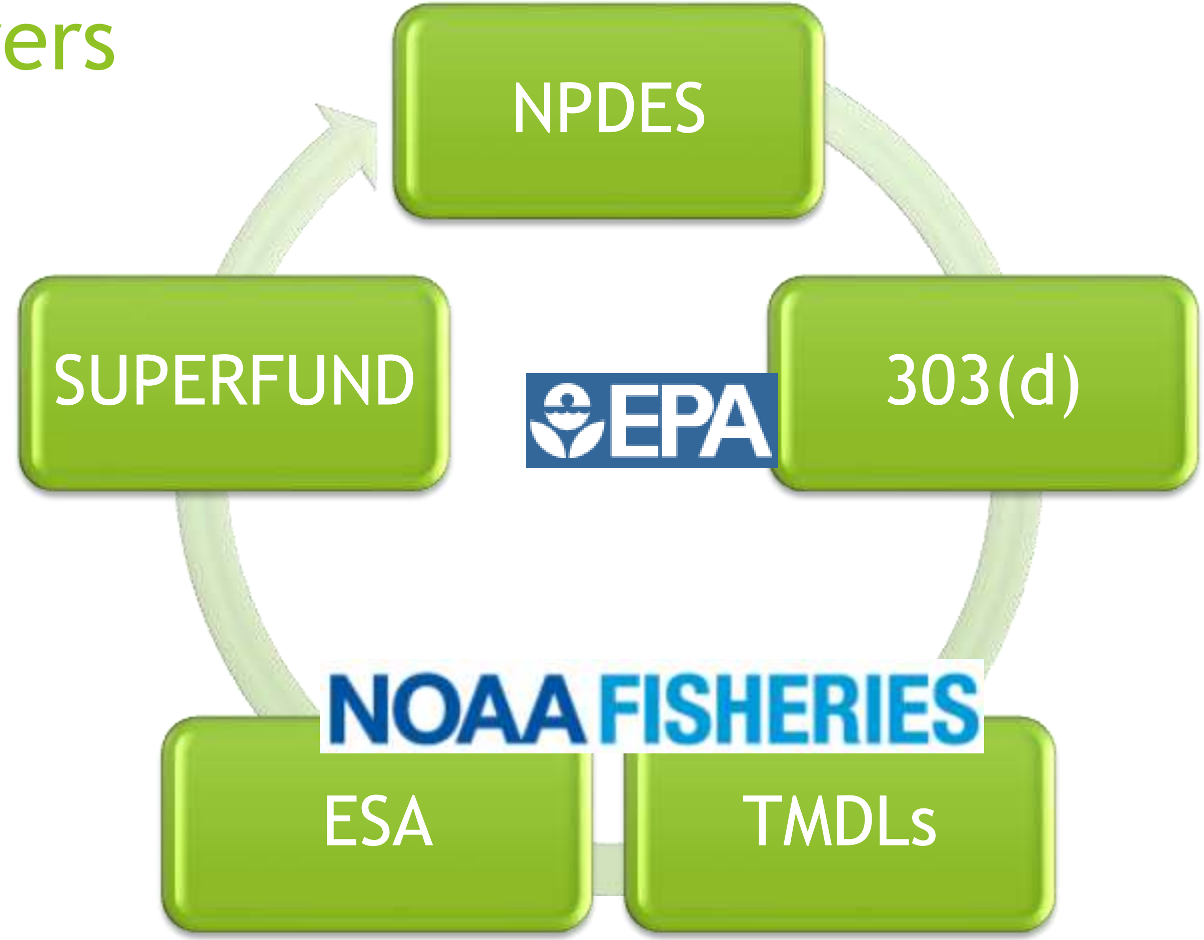


Regulatory Drivers



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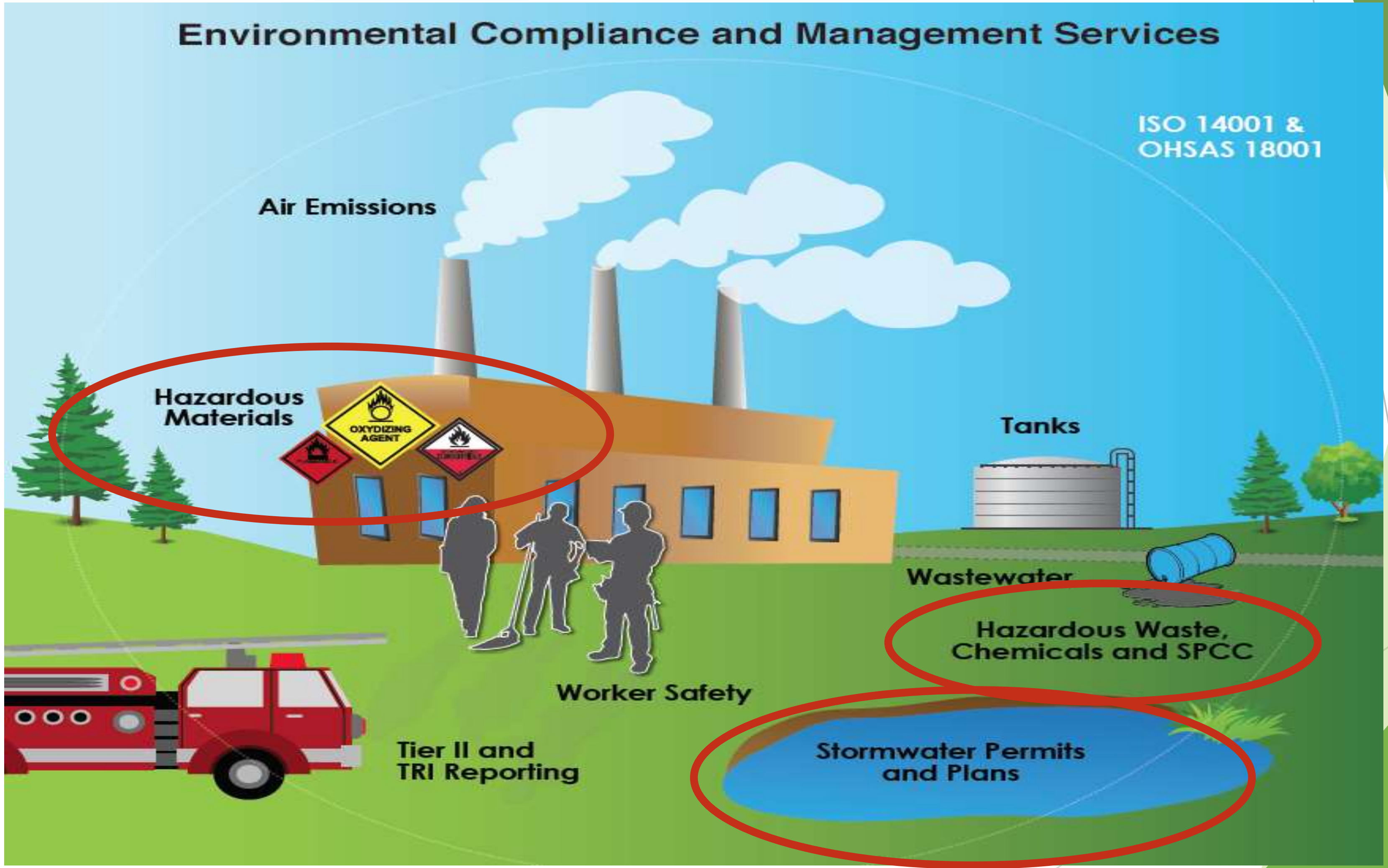
Industrial Compliance vs Stormwater/GW Protection



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Industrial NPDES Compliance

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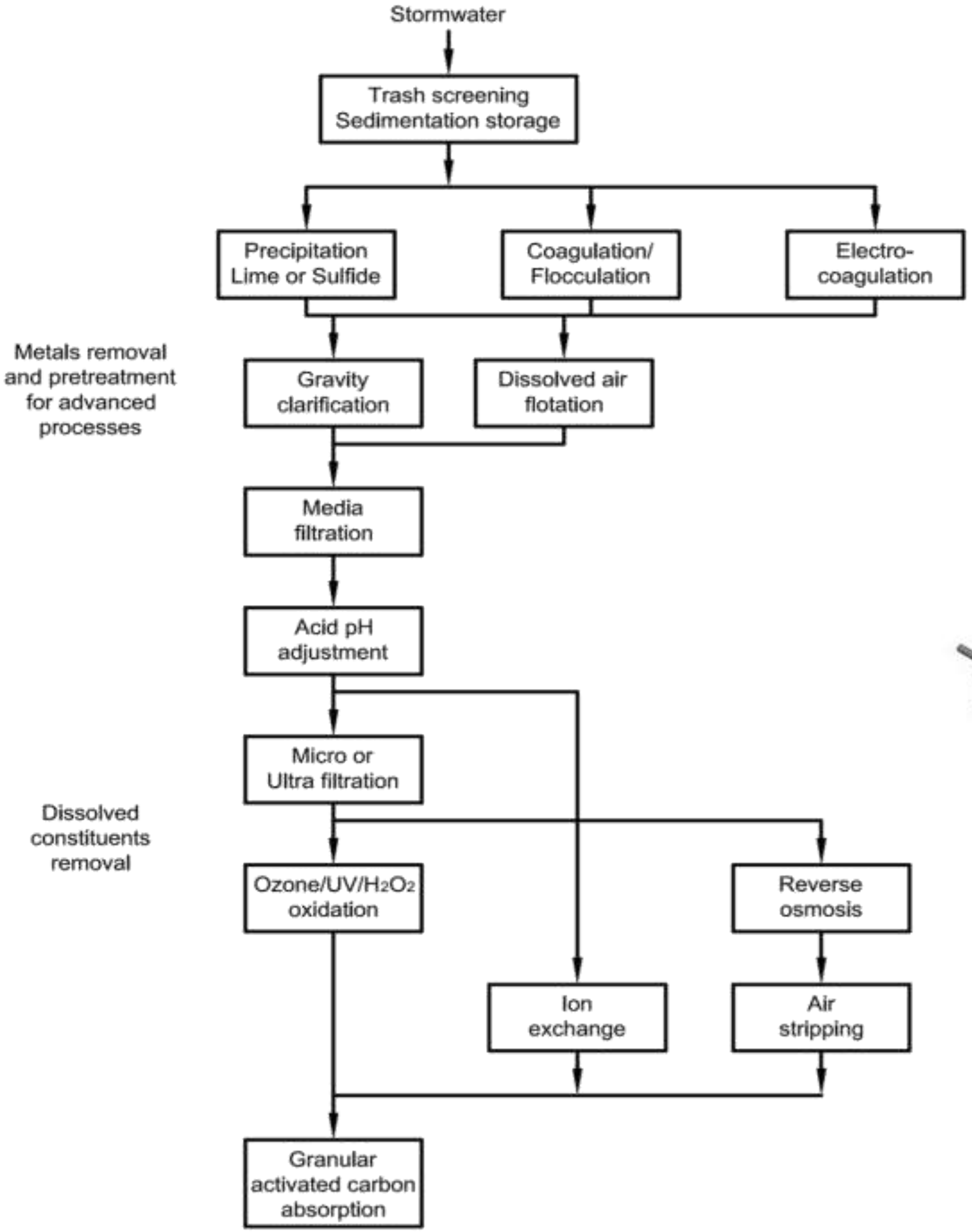
Industrial Waste Management (Treatment)	Industrial Programmatic Compliance (SWPPP)	Industrial Stormwater Management
▶ Essentially waste water treatment compliance ▶ Byproduct of a treatment process (effluent) ▶ Driven by numeric criteria compliance – meet the criteria or lose the ability to discharge ▶ Effluent meeting discharge requirements does interact with outside surface and groundwater resources ▶ Typically handled by outside offices	▶ Policy based regulation ▶ Best practices tied to safety, separation, and containment ▶ Think of it as a guidebook for site management of how-to-do and deal with everyday industrial handling of materials. ▶ Properly performed greatly limits or completely separates water resources interaction ▶ Typically non-numeric	▶ Designs used to comply with local stormwater compliance ▶ Typically driven by local controls, such as water quality protection ▶ Typically driven by numeric control standards. ▶ Part of civil design process and stormwater permitting

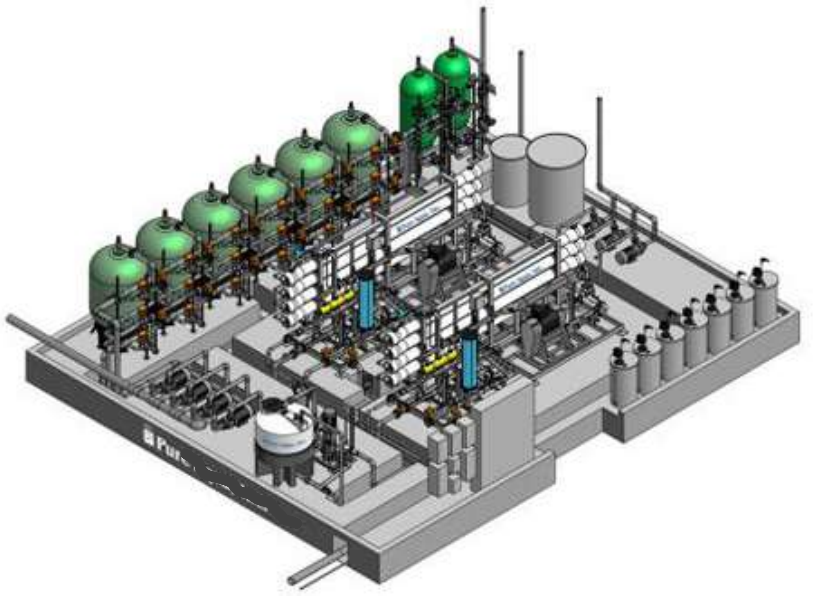
Hazardous Material Separation - Mechanical, Structural, Electrical

- May be needed at highly constrained sites with low effluent limits (e.g., industrial settings)
- Often use of chemicals and/or high energy
- Waste liquid streams to recycle and/or disposal
- Residual solids that need dewatering/disposal
- Costly

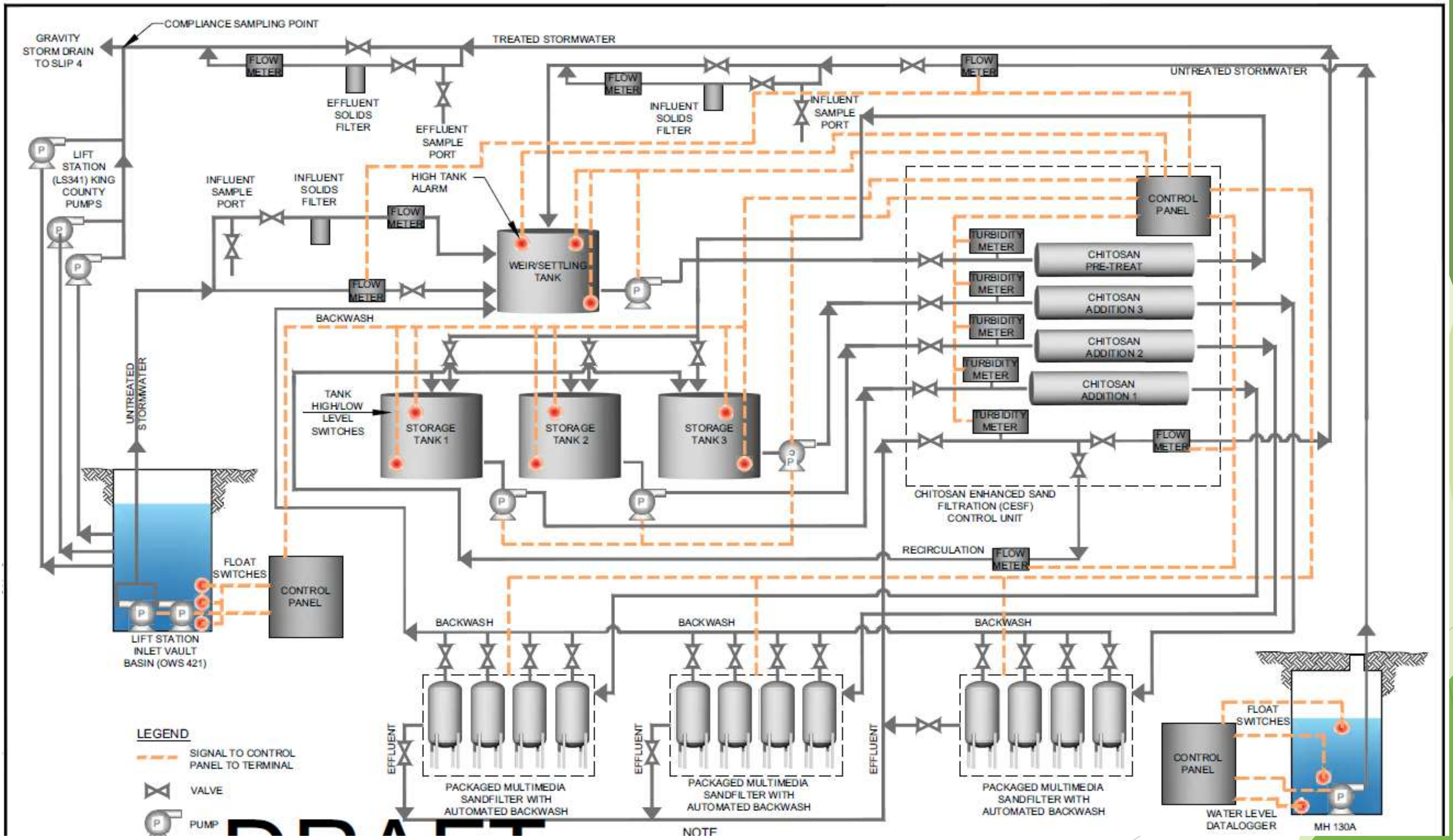
More Consistent & Reliable Performance

Active Treatment Combinations





Sustainable Stormwater Management?



Overview of Post Construction BMPs

- Programmatic/Policy: controls put in place independent of design (Typically SESC) as measures to ensure Quality Control regardless of project (SWPPP).

- Design Based (Structural): controls put in place specific to the design to address a specific pollutant, pollutants, control volume, infiltrate or otherwise perform stormwater practices not typically performed through traditional stormwater practices.

- Design based (structural) BMPs are the focus of this presentation for Geosyntec.

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Overview of Programmatic BMPs

Programmatic Best Management Practices

- Often detailed in the facility’s Stormwater Pollution Prevention Plan (SWPPP)
- Means of preventing various materials from interacting with stormwater
  - Drip pans
  - Floor drains which connect to sanitary sewer rather than storm sewer
  - Covered, weather resistant fuel sheds
  - How to deal with spills
  - May be driven by NPDES permit, State fire code, adopted MS4 policies, etc.
  - Several of the above are addressed through product vendors

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Site Map – Pertains to a SWPPP

Example Inspection Process

Photograph 1. Oily storm water, gravel, and absorbent is accumulated in trash truck parking area.

Photograph 2. Large amount of used, dirty absorbent at fuel island.

Photograph 3. Trash collection truck leaking hydraulic fluid to surface of parking lot.

Housekeeping

Sediment Control Maintenance

Pavement Maintenance

Inlet Protection

Wash-Water Control

Repair and Maintenance

Good Spill Control

Potential Industrial Stormwater Runoff Source Pollutants (examples)

- Current Stormwater Pollutants
  - Copper, lead, zinc (automotive and building materials)
  - Dioxin (general atmospheric)
  - Phthalates (PVC, hydraulic fluids, atmospheric)
  - PAHs (automotive, treated wood, atmospheric)
  - Pesticides (landscaping)
  - Nutrients (landscaping)
- Legacy Pollutants
  - PCBs (but still circulating)
  - Mercury (but still circulating)
  - Other Pesticides (e.g., DDT, chlordane)
  - Lead (larger concentrations – older development)

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Structural BMPs for Stormwater

Overview and Focus

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Overview of Structural Stormwater BMPs

- Stormwater runoff from industrial areas may have concentrations of pollutants that may be of concern for local surface waters and underground aquifers

- Stormwater volumes can contribute to migration of sources even if “clean” (stormwater runoff to infiltration and resulting pollutant movement to sediments)

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Regulating Runoff as a Pollutant

- More Impervious Surface = More Volume
  - More volume leads to greater washoff
  - Mobilizes more material
  - Move volume can carry the material further distances
  - Changing climatic patterns – More rainfall volume?
- Problem – what happens to a stream or downstream body of water which has remained the same size and receives all the water

- FLOOD

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Example Conceptual Site Model

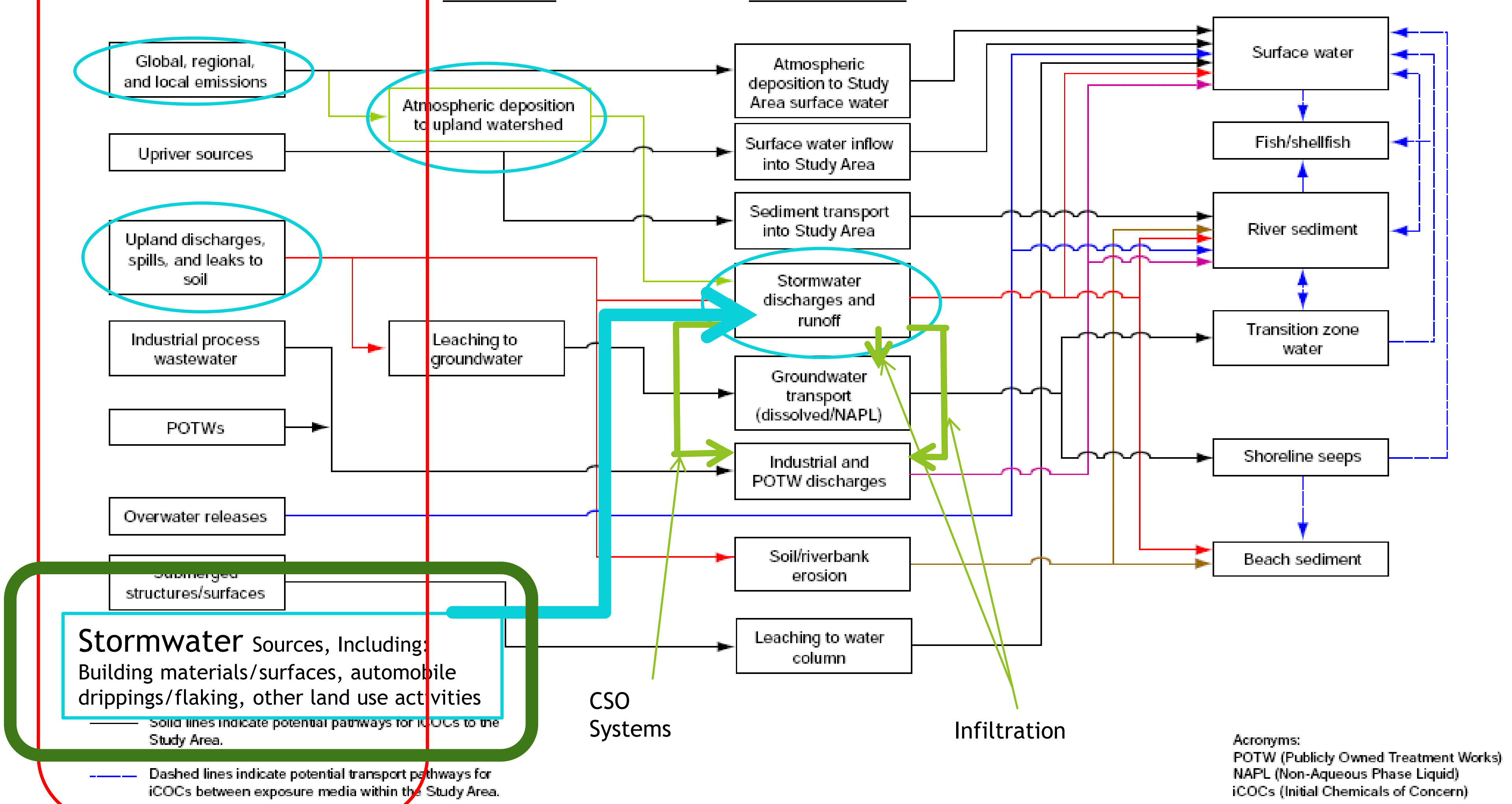

Figure 11.0-1
Portland Harbor RI/FS
Comprehensive Round 2 Report
Physical Conceptual Site Model

integral consulting inc.
LWG Lower Willamette Group
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Protecting Surface and Groundwater

What are the Protection Goals?

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Protection Goals – End User

- Could be driven by regulatory agency
  - USACE
  - NPDES-MS4
- Could be an impairment
  - 303d list – locally Fox River for Phosphorus (ex.)
- Could be fish or animal protection
  - Anadromous fish – Pacific Northwest
- Could be a drinking water source
  - Surface water or groundwater

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Protection Goals – End User

- How does one define protection?
  - Typically it is done numerically
- Otherwise how do you know water is safe to consume?
  - Bottle of water vs
  - Glass of water from tap vs
  - Cup over water from the creek

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Protection Goals – End User

- Much of the nation employs numerical goals and model driven simulations to conceptually demonstrate compliance
- McHenry County does not

$$
\begin{aligned}
a+b)G_\lambda(a,b) &= 1 + \lambda \int_0^\infty dp \left(\frac{G_\lambda(p,b) - G_\lambda(a,b)}{p-a} + \frac{G_\lambda(a,b)}{1+p} \right) \\
&+ \lambda \int_0^\infty dq \left(\frac{G_\lambda(a,q) - G_\lambda(a,b)}{q-b} + \frac{G_\lambda(a,b)}{1+q} \right) \\
&- \lambda^2 \int_0^\infty dp \int_0^\infty dq \, \frac{G_\lambda(a,b)G_\lambda(p,q) - G_\lambda(a,q)G_\lambda(p,}{(p-a)(q-b)}
\end{aligned}
$$

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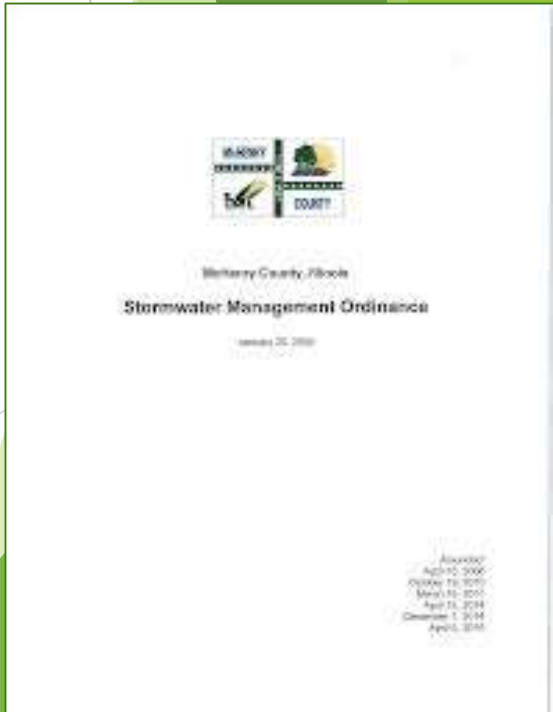
McHenry County Stormwater Management Ordinance (SMO)

Review of McHenry County Stormwater Ordinance Language:

- Non-numeric standard
- Article VI.B.7.a.(1)…remove both floatable and settleable pollutants from as much of the stormwater runoff from increased impervious areas as possible…through hydrodynamic separator, or into catch basin fitted with a hooded outlet cover.
- Appropriate “pretreatment”. Defined in SMO: BMPs used to remove pollutants from stormwater prior to infiltration
- Is the BMP sized correctly?
- Is the BMP maximizing its return?
- Is the BMP best suited for the job/site?



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McHenry County Stormwater Management Ordinance (SMO)

Current problems with non-numeric targets:

- Creates a moving target- did we make the goal?
- Inconsistent review from municipality to municipality
- Interpretative differences

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McHenry County Stormwater Management Ordinance (SMO)

Benefit of Numeric goals/standards:

- Ensure structural BMP meets target of design?
- Ensure structure is not underutilized or overburdened
- Minimizes interpretive issues
- We already possess the tools to do this!

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BMP Selection Process

For Industrial Land Use

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Stormwater Source and Treatment Control Process

STEP 1
Define Overall Objectives

↓

STEP 2
Identify Primary Pollutants of Concern

↓

STEP 3
Identify Applicable Unit Operations and Processes (UOPs) for Removal of Primary Pollutants of Concern (POCs) / Chemicals of Interest (COIs)

↓

STEP 4
Identify Other Factors/Constraints That May Affect Treatment BMP Selection

↓

STEP 5
Verify BMP Performance of Potential Treatment BMP Options for Removal of Primary Pollutants of Concern

↓

STEP 6
Select Treatment BMPs Based on Primary Pollutants of Concern, UOPs for Targeting Primary Pollutants of Concern, Other Factors/Constraints, and BMP Performance

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Step 1: Define Overall Objectives

- Meet/exceed regulatory requirements
- Reduce to negligible the potential to contribute to recontamination of sediments via either **stormwater** pollutant sources or contributions to Storm Sewer Overflows
- Appropriate for site conditions (e.g., land use types, topography, soil types, depth to groundwater, contamination characteristics) should be evaluated?
- LEEDs, etc.

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Step 2: Identify Primary Pollutants of Concern – Land Use Based

Land Use	Pollutant Category of Concern									
	Pathogens	Metals	Nutrients	Pesticides	Organic Compounds (hydrocarbons, oil & grease, solvents, PAHs)	Sediments	Trash & Debris	Oxygen Demanding Substances (green and food waste; sewage)	Chloride	Hydromodification(6)
Residential Development	X	P(2)	X	X	X	X	X	X	P(5)	P
Commercial/Institutional Development	P(1)(3)	P(2)	P(1)	P(1)	X	P(1)	X	P(1)(3)(4)	P(5)	P
Industrial Areas	P(1)	X	P(1)	P(1)	X	P	X	P(1)(3)(4)	P	P
Automotive Repair Shops	P(1)	X	P(1)	P(1)	X	P(1)	X	P(1)(4)	P(5)	P
Restaurants	X	P(2)	P(1)	P(1)	X	P(1)	X	X	P(5)	P
Parking Lots	P(1)	X	P(1)	P(1)	X	P	X	P(1)(4)	P(5)	P
Streets, Highways & Freeways	P(1)	X	P(1)	P(1)	X	X	X	P(1)(4)	P(5)	P

X = anticipated P = potential

(1) A potential pollutant if landscaping exists on-site or there is active construction
(2) A potential pollutant if the project includes uncovered parking areas
(3) A potential pollutant if land use involves food or animal waste products
(4) A potential pollutant if combined sewer overflows, illicit sewage discharges, or septic systems are present
(5) A potential pollutant if snow removal activities are performed
(6) A potential pollutant depending on location of the project within in the district and the receiving water(s)

Step 3: Identify Applicable Unit Operations and Processes (UOPs) for Removal of Primary Pollutants of Concern

STEP 3
Identification of Applicable Fundamental Process Categories (FPCs)

Select Applicable Hydrologic Operations

(Peak Attenuation, Volume Reduction)

Select Applicable Physical Treatment Operations

(Particle Size Alteration, Size Separation, Density Separation, Aeration, Volatilization, Physical Agent Disinfection)

Select Applicable Biological Processes

(Microbially Mediated Transformations, Uptake and Storage)

Select Applicable Chemical Processes

(Sorption Processes, Flocculation /Precipitation,Chemical Disinfection)

Select

Set of Applicable Unit Operations and Processes

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Chemical Processes (examples)

Fundamental Process Category (FPC)	Unit Operation or Process (UOP) Target Pollutants	Typical Treatment System Components (TSCs)
Chemical Processes	Chemical Sorption Process Metals, nutrients, organic pollutants	Subsurface wetlands Engineered media/sand/compost filters Infiltration/exfiltration trenches and basins
	Coagulation/Flocculation Fine sediment, nutrients	Detention/retention ponds Coagulant/flocculant injection systems
	Ion Exchange Metals, nutrients	Engineered media, zeolites, peats, surface complexation media
	Chemical Disinfection Pathogens	Custom devices for mixing chlorine or aerating with ozone Advanced treatment systems

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Step 4: Identify Other Factors/Constraints That May Affect Treatment BMP Selection - BMP Practicability Screening Matrix

BMP Type	Critical Design Parameters	Typical Pollutants Removed	Major Constraints	Maintenance Requirements
Wet Pond	Length to width ratio; Stage-discharge relationship; Permanent pool and surcharge capacity; Maximum depth; Base flow; Plant selection; Flow rate diversion for off-line facilities	High removal efficiency of coarse solids, suspended solids, trash, and debris; Some removal of dissolved solids, total phosphorus, soluble nutrients, trace metals, coliform and organics; Low volume reduction	Surface space availability; Depth of excavation; Compatibility with flood control; Vector control	Dredging required approximately every 5 years with reestablishment of pond bottom; Side slope upkeep; Trash and debris removal; Periodic inspections; Removal of algal mats and control of fringe vegetation
Bioretention	Soil characteristics and amendments; Depth to groundwater; Area and ponding depth; Storage capacity; Plant selection	High removal efficiency of coarse solids, trash, and debris. Moderate removal of suspended sediment, metals, and bacteria. Variable removal of nutrients; Low to high volume reduction	Field infiltration rate; Depth to groundwater; Contaminated soils; Proximity to storm drain; Vertical relief and proximity to storm drain; Surface space availability	Semi annual, annual, and post-storm inspections; Vegetation upkeep; Periodic surface scarification and sediment removal
Infiltration Facilities	Min/Max infiltration rate; Depth to groundwater; Storage capacity	High removal efficiency of coarse solids, particulate and suspended sediment; Moderate removal of phosphorus/nitrogen; Dissolved metals and pathogen removal dependent on soil types; High volume reduction	Field infiltration rate; Depth to groundwater; Contaminated soils; Proximity to structures; Large drainage area	Semi-annual/annual and post-storm inspections; Vegetation upkeep; Periodic surface scarification and sediment removal

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Step 5: Design/Verify BMP Performance of Potential Treatment BMP Options and Sizing/Design for Removal of Primary Pollutants of Concern

International BMP Database Recommended Performance:

- How much stormwater runoff is prevented? (“hydrological source control”)
- How much of the runoff that occurs is treated by the BMP or not (“hydraulic performance”)?
- Of the runoff treated, what is the effluent quality? (“concentration characteristics achieved”) How does it compare with Pollutants of Concern levels?
- *Does the BMP address downstream erosion impacts?*

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Protecting Surface and Groundwater

What are the Protection Goals?

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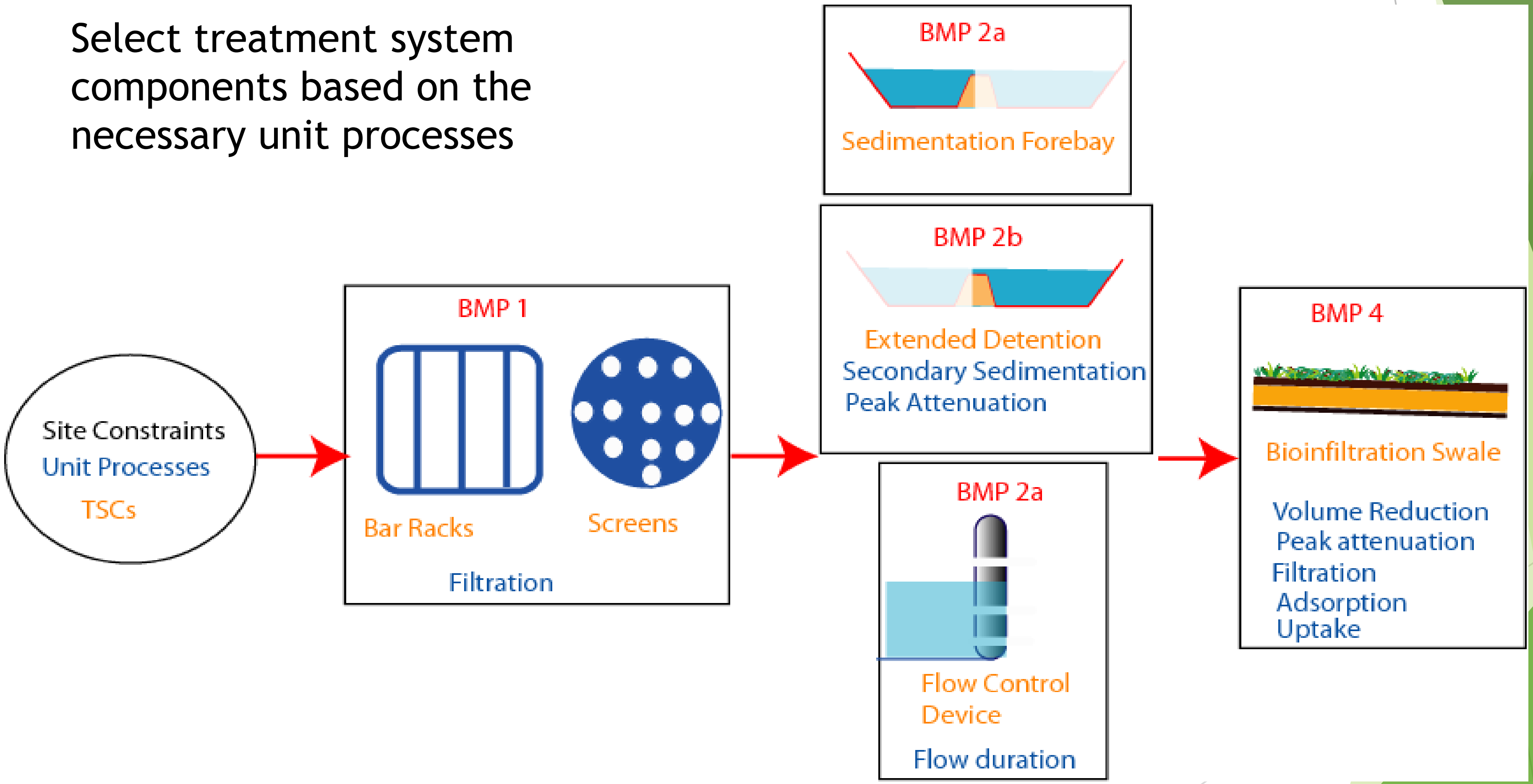
Treatment Trains

Select treatment system components based on the necessary unit processes



Example conceptual train to treat TSS and dissolved copper, while also providing flow duration control

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Green Infrastructure

Slow

Biotreatment
(Swale)

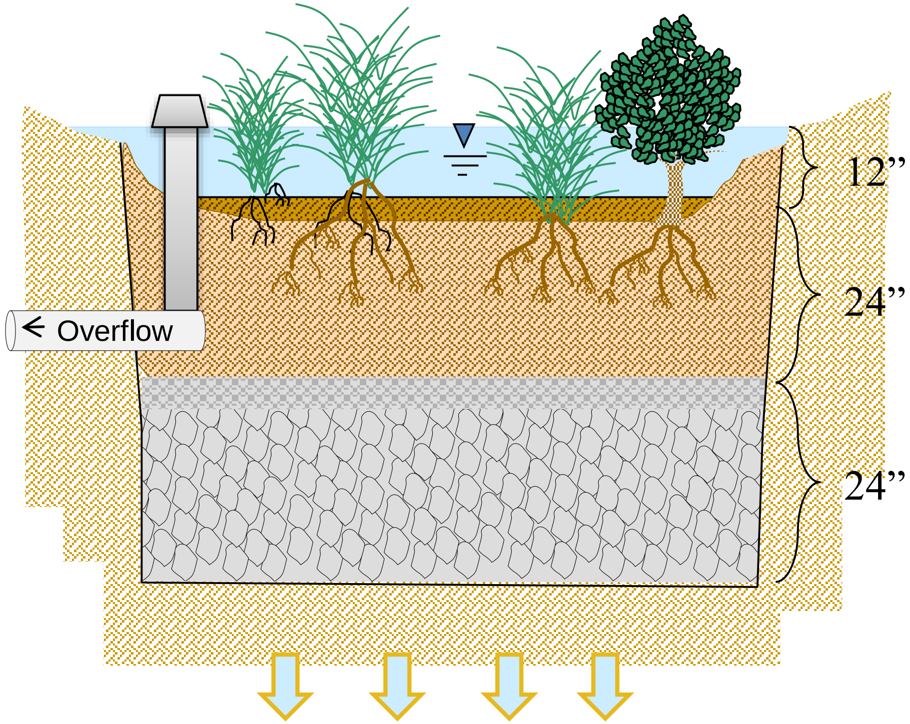
Infiltration
(Trench)

Capture & Use
(Cisterns)

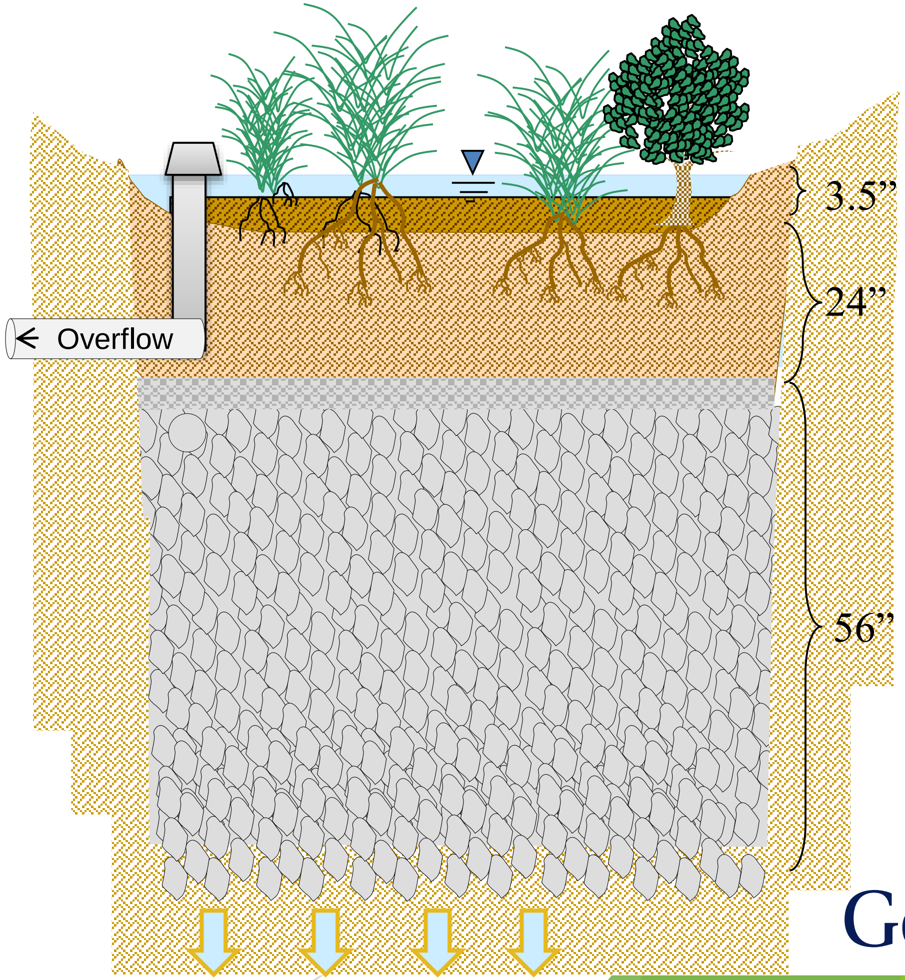
Regional
Infiltration

Sump Storage to Maximize Infiltration

Infiltration rate = 0.5 in/hr



Infiltration rate = 0.1 in/hr



*Surface depth limited to 72 hour drawdown time, so add volume to stone reservoir

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Applications

Sand Filter Bed

Bioretention

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Sand Filter: Kent, Washington

BMP Design Steps

- Define the overall objective
- Identify the governing agency and determine basis of design
- Identify appropriate BMP technology and design parameters
- Design BMP

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Define the Overall Objective

- The Industrial Facility will have a numeric effluent criteria for zinc in 2020
  - In the state of Washington, numeric criteria are used to derive the water quality-based effluent limits for a point source discharge permit
- Understand how the pollutant is entering the stormwater – galvanized metals leach zinc into stormwater
- Facility must install a BMP that captures and treats stormwater prior discharge

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Identify the governing agency and determine basis of design

- Industrial Facility is located in City of Kent in King County
  - City of Kent 2017 Surface Water Design Manual adopts the 2016 King County Surface Water Design Manual

- Basis of Design
  - 80% TSS Removal – TSS removal leads to an indirect removal of other pollutants that adhere to suspended solids
  - 91% of the total runoff volume must be treated (continual simulation of 6-month, 24-hour storm event)

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Identify appropriate BMP technology and design parameters

- BMP Technology – Detention Basin versus Sand Filter
- Driving Design Parameters
  - Pre-settling treatment – 0.25 x basic water quality treatment volume (minimum 3 feet depth and maximum 6 feet depth)
  - Filtration Rate – minimum 1 in/hr
  - Ponding Depth – maximum 6 feet
  - Sand Depth – minimum 1.5 feet
  - Overflow Structure – 100-year, 15-minute

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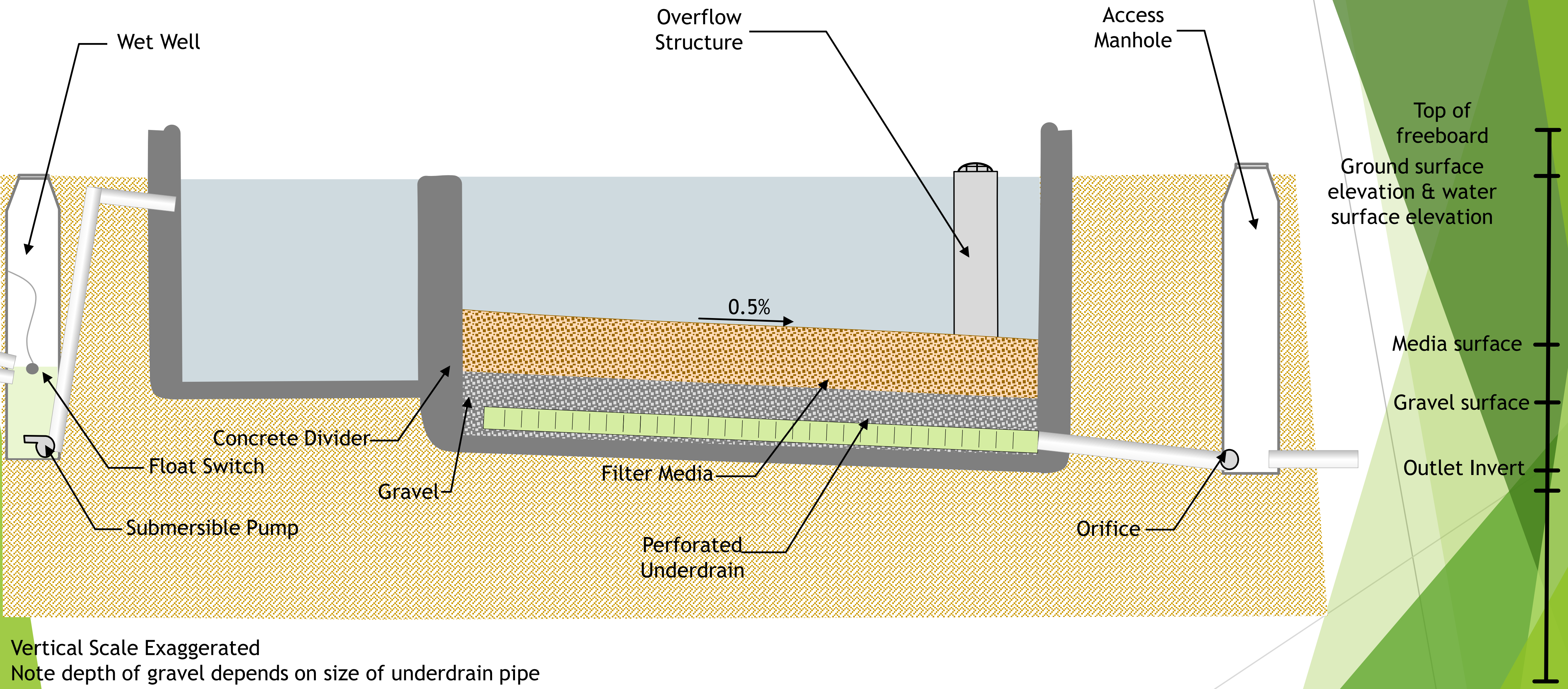
Conceptual Sand Filter Vault Design



Vertical Scale Exaggerated
Note depth of gravel depends on size of underdrain pipe

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Sand Filter Vault

Bioretention Cell: St. Louis, MO

BMP Design Steps

- Define the overall objective
- Identify the governing agency and determine basis of design
- Identify appropriate BMP technology and design parameters
- Design BMP

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Define the Overall Objective

- The City of St. Louis Metropolitan Sewer District (MSD) is under a consent decree with EPA and Missouri Coalition for the Environment
  - MSD is required to spend $4.7 to address issues with overflows and other storm sewer systems
- Part of MSD’s Rainscaping Large Grants program
- Design a BMP that captures and detains stormwater
  - Volume reduction – volume of water discharging from BMP is less than volume captured through evaporating, transpiring, and infiltration

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Identify the governing agency and determine basis of design

- Site is within St. Louis MSD limits and must adhere to:
  - 2018 St. Louis MSD Rules and Regulations and Engineering Design Requirements
  - MSD BMP Toolbox Stormwater Quality Performance Criteria

- Basis of Design
  - Minimum storage of 75% of the Water Quality volume
  - Pre-treatment is necessary for drainage area >0.5 acres and should be sized to store 25% of Water Quality volume

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Identify appropriate BMP technology and design parameters

- BMP Technology – Detention Basin with filter strip for pretreatment

- Driving Design Parameters
  - Water Quality Rainfall Depth – 1.14 inches
  - Drainage Area Percent Impervious
  - Maximum Ponding Time – 2 days
  - Maximum Ponding Depth – 1.5 feet
  - Bioengineered media – 2.5 feet
  - Vegetation must withstand flow velocities from 15-year, 20-minute storm event

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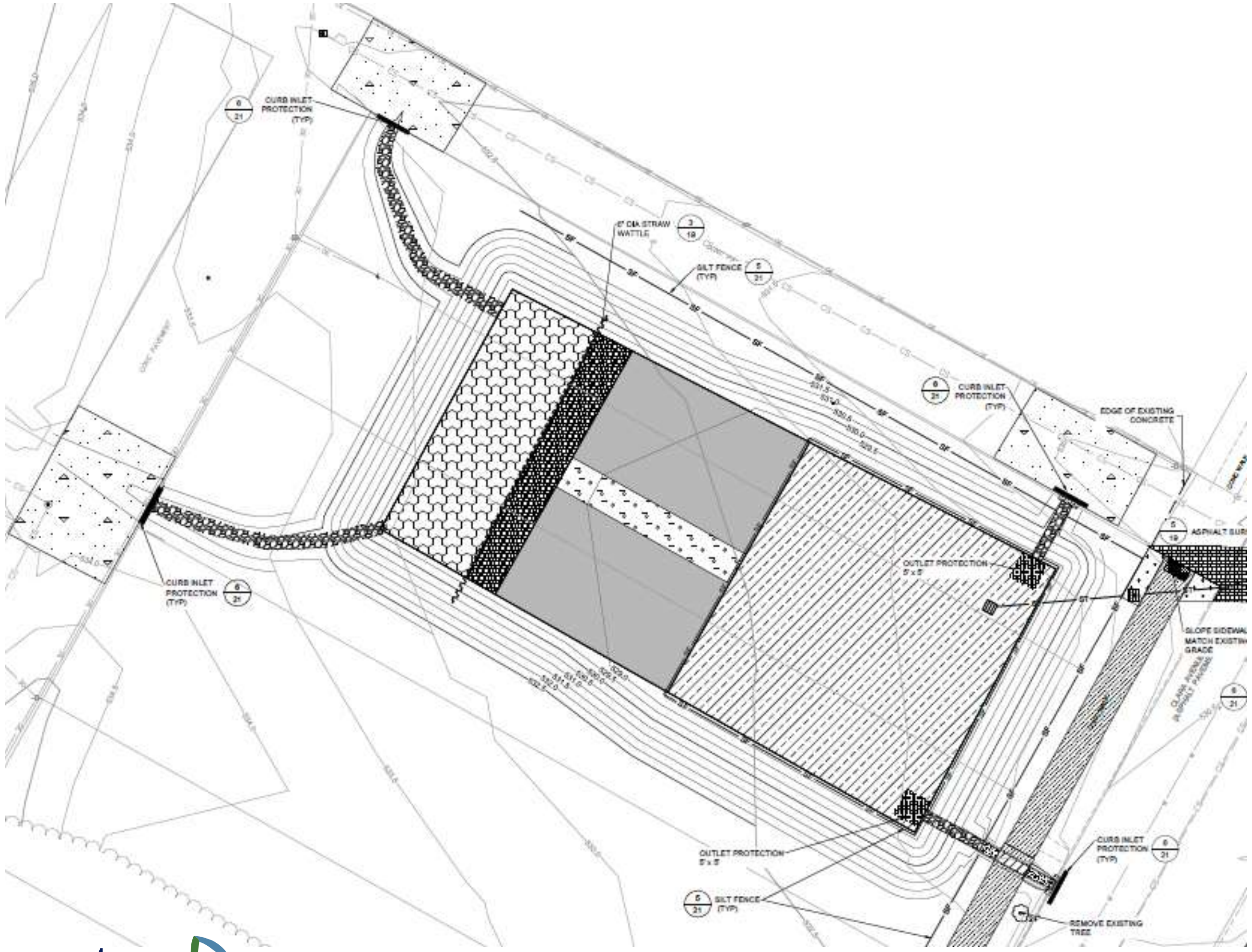
Bioretention Cell design



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Additional Considerations Alongside BMP's

Emphasizes the importance of numeric criteria

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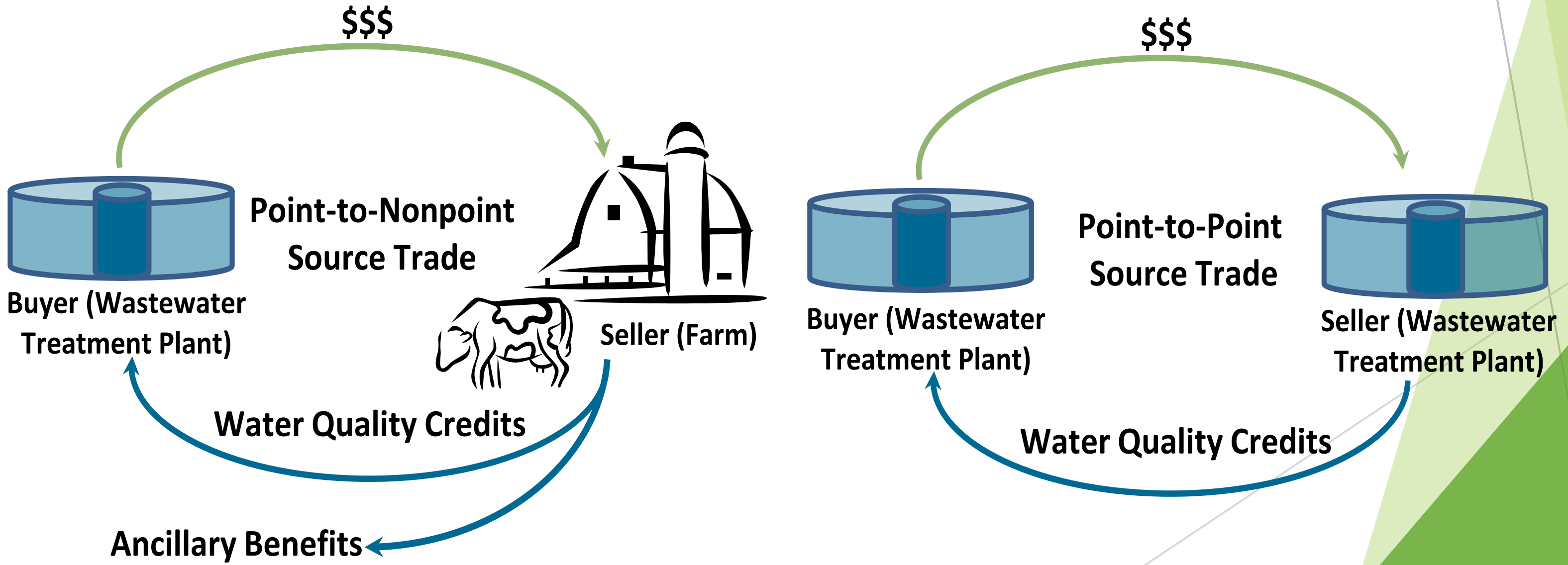
What is Water Quality Trading?

- Market-based compliance system where one discharger buys or sells pollution credits from another
  - Point-to-Point
  - Point-to-Nonpoint
  - Nonpoint-to-Nonpoint
  - Not only nutrients (total suspended solids, temperature, etc.)



Nutrient Trading in Missouri: Critical Policy Factors and Program Recommendations (Feb. 2013)

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Take Always

- Regulatory requirements and difficult site constraints are increasingly driving more rigorous analyses and innovative designs
- Designs need to be adaptable to the changing requirements
- Permittees should question the technical basis for new requirements (if non-numeric)
- Consider challenging them if there are not adequate “off-ramps” or provisions for demonstrating infeasibility and selecting the most <u>cost-effective</u> and <u>reasonable</u> solution

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QUESTIONS??

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